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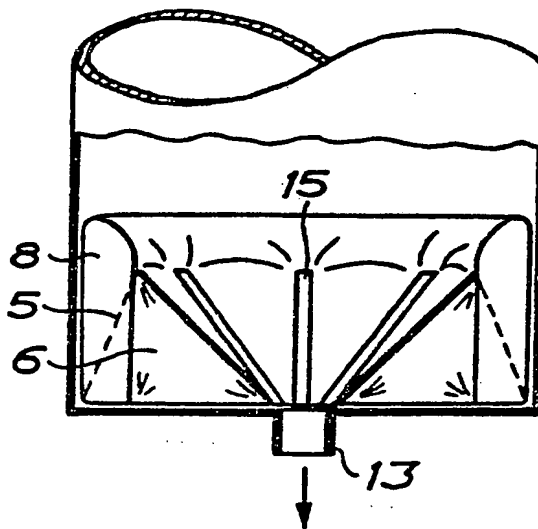
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With international search report.

(54) Title: A DEVICE FOR FINAL EMPTYING OF A CONTAINER



## (57) Abstract

A device for final emptying of a silo. A membrane (1) covers the bottom of the silo and extends along the sidewalls of the silo. The membrane is double-sided and forms a closed bladder or space (8), in which air can be fed, with one surface abutting the bottom surface of the container. Triangular partitions (6) are arranged between the upper part and the lower part of the membrane and extend from the outlet opening and radially towards the sidewalls of the silo. When the space (8) below the membrane is inflated with air, the sidewalls are stretched and urges the upper surface of the membrane (1) to form a conical plane having essentially the sliding angle of the material. The partitions (6) are connected to the membrane (1) with seams (2). The seams may be reinforced with strips (15).

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## A DEVICE FOR FINAL EMPTYING OF A CONTAINER

Field of invention.

The present invention relates to an apparatus for final emptying of bulk goods from a container through an opening in or in the vicinity of the bottom surface thereof.

In the present specification, the expression containers means silos, railway goods waggons, trucks, containers, ship storage rooms etc, which contain bulk goods such as grain, cement, coal, wood chips, sand, chemicals etc. However, the invention is not limited to the types of containers mentioned above, but all types of containers are encompassed, which may include bulk goods. Also other types of bulk goods are encompassed than those enumerated above.

Prior art:

There are many previously known apparatuses for discharging hard-flowing, arching types of goods from silos, confer e. g. the Swedish patent specification No. SE-C-7611862-9. Such devices are however most often not usable for light flowing goods or fluidizing bulk goods. The technique of discharging such silos is to provide them with a hopper, which is conical, axe-shaped or wedge-shaped.

These hoppers have an angel in relation to the horisontal which is 45° to 90° depending of the type of goods and the sliding angle therof. It is easily recognized that these hoppers drastically increase the costs of the silo, partly due to their complex design and partly due to the fact that the silo volume available is decreased.

Silos having uniform goods without any claim for first-in-first-out, e. g. sand, dressed ore and similar heavy bulk goods, are instead build on a firm ground having a plane bottom with one or several outlet openings to culverts or conduits positioned therebelow or with outlet openings at the lower portion of the vertical wall.

The goods stored in the silo will form its own slide plane. However, due to the goods pressure from the material postioned above, said goods is compressed to the limit of petrification and will grow til stalagmitic statues which finally occupy a considerable portion of the storage volume of the silo and cause a considerable storage cost.

In other cases, e. g. at grain, it is desired to completely empty the silo for changing to another type of grain.

Mechanical macines for final emptying are previously known. While these must be able to work at large areas, they often become economically

uninteresting.

The most common method today of final emptying is by hand by means of shovels, pitch-forks and hoes and in the more difficult cases by means of dynamite and nitrolite. However, the manual final emptying is far from riskless and is moreover a very unpleasant working environment.

What has been said above regarding the emptying of silos is also valid for stationary containers and transportable containers and cargo spaces in e. g. ship spaces. Since it rather pertains to handling and less to storing, the containers and the cargo spaces must be completely emptied during each handling cycle. A decrease of the handling time is a considerable economic gain.

In the French patent specification FR-A-2.398.684 there is shown and described a device for final emptying of a container, wherein the emptying takes place through a lid at the lower longitudinal edge of the container. The container is provided with a membrane, which covers one of the side walls of the container opposite the lid, the floor of the container and both transversal walls along their diagonals. When the container is to be emptied, air is supplied to the space between the container and the membrane is inflated and displaces the material, which slide out through the opened lid. With this technique, the container may easily be emptied from its bulk goods without any trouble. In Fig. 7 of this patent specification it is suggested that this technique can be used for emptying of cylindric containers having a central opening. However, at the inflating of the membrane there will occur a compression and desorientation of the membrane of purely geometric reasons, which completely makes it impossible to empty the last portion of the bulk goods.

It would be desirable to be able to use this technique at the emptying of cylindric containers such as silos. The present invention provides a solution to this problem and makes it possible to use this technique at cylindrical containers having a central opening in the bottom surface of the container. The same technique can of course be used also for rectangular containers and also for containers having one or several outlet openings at the side thereof.

In United States patent specification US-A-3.202.461 there is disclosed an automatic unloading device for elongated containers comprising a raisable fluidizing strip as a discharging mechanism. This device is specifically intended for horizontally elongated containers. The container is lined with a lining disposed to rest on the adjacent inside surface of the container and the top edge of the lining is secured by a gas-tight seal in a horizontal plane about the inside perimeter of the container to form a gas-impervious pocket between the lining and the inside lower portion of the container which may be inflated. A double lining can be used. However, this patent is not directed to solve the problems associated with cylindrical containers of a substantial height, such as silos. In such an environment as a silo substantial forces arises when the membrane is inflated. It is not sufficient to anchor the membrane at the bottom of the silo since it is not easy to obtain an anchorage which is

strong enough to resist the forces exerted in the holding down wires if such are used. Neither can the membrane be hold down by a line attachment to the bottom of the container, while the bottom of the container cannot withstand such high forces but ruptures.

#### Summary of the invention.

The object of the present invention is to provide an apparatus for final emptying of a container which can be used in silos or other container having a great height, in which the pressure of the material is substantial.

Accordingly, there is provided a device for final emptying of a container which contains bulk goods to be fed out through one or several outlet openings or to an outlet device in or adjacent the bottom surface of the container, whereby an essentially air-tight membrane is covering the bottom surface of the container and at least a portion of the side walls but leaving the outlet opening free. According to the invention, the membrane is double-sided and forms a closed bladder or space with one surface abutting the bottom surface of the container. A device for holding down a portion of the membrane is attached close to the outlet opening. Said device for holding down the membrane is triangular partitions attached between the upper and the lower part of the membrane and directed from the outlet opening. The partitions are attached to the membrane by seams or welds so that the forces exerted when the space between the partitions and the membrane is inflated is completely taken up by the membrane itself and the membrane is bulging out between the partitions both at the bottom part and at the upper part thereof. The device for holding down may further comprises essentially rigid sliding planes directed towards the outlet opening and attached to the upper part of the membrane. The membrane may further be provided with a device for urging the membrane to be positioned flat across the bottom of the container after the final emptying of the container when the air inside the membrane is expelled.

#### Summary of the drawings.

The invention is described more in details below by means of preferred embodiments of the invention and by reference to the accompanying drawings, in which;

Fig. 1 is a perspective view partially in section of a cylindric silo having a side opening for emptying of the silo. The silo has been emptied to the natural slide angle of the goods and uses the apparatus according to the invention;

Fig. 2 is a perspective view partially in section similar to Fig. 1 of a cylindric silo having a central outlet opening;

Fig. 3 is a cross-sectional view similar to Fig. 1 showing the operation of the invention, whereby air is supplied below the membrane so that the goods can flow out;

Fig. 4 is a cross-sectional view similar to Fig. 1 showing the corresponding effect in a silo having a central outlet opening;

Fig. 5 is a perspective view partially in cross-section of a mobile container having central bottom openings for emptying of the container;

Fig. 6 is a cross-sectional view of the membrane showing the connection of the slide plane to the membrane.

Description of the preferred embodiments.

In Fig. 1 there is shown a cylindric container 10 provided with a final emptying apparatus according to the invention. The container 10 can be a silo having a plane bottom and is emptied through an opening 13 in the side thereof. In Fig. 2 there is shown a silo 10 having central emptying in the silo bottom 7.

The final emptying apparatus according to the invention comprises a membrane 1, which is connected around the outlet opening 13 and covers the bottom 7 of the container 10 and extends upwards along the side walls of the container as shown in Figs. 1 and 2. The membrane 1 forms a closed space 8 in the silo at the bottom thereof, in which space 8 air can be supplied through an inlet 11.

When the silo is emptied, the bulk goods will initially flow out through the opening 13 until the goods reaches the level shown in Figs. 1 and 2. The goods form a slide plane, the angle of which is dependent on the specific properties of the goods.

When the goods stop flowing out through the opening 13, there is supplied air through the inlet 11, whereby the space inside the membrane is filled with air. Thus, the slide angle of the goods is once again exceeded and the goods is finally discharged through the opening 13.

The air is supplied at an inlet 11 placed immediately adjacent the top portion of the membrane. The pressure of the bulk goods is lowest in this position and thus only a relatively low pressure is required in the supplied air in order to entail that the upper portion of the bulk goods is lifted somewhat and is caused to slide or flow downwards towards the opening 13. In this way it is assured that the membrane is firstly filled with air at the upper portion of the closed space adjacent the inlet 11, where the pressure from the bulk goods is lowest, and the most effective emptying is achieved.

According to the invention, the membrane comprises an attachment device for holding down the membrane, in the nature of vertical partitions 6, which are shown in greater details in Figs. 3 and 4. Each partition 6 is triangular and extends from the inlet opening 13 and essentially radially in the direction from the opening. The partitions 6 are attached to the membrane 1 by means of seams or welds 2 and are also attached by seams or welds to the lower portion of the membrane. In the rest position according to Fig. 1, the partitions lie folded between the membrane portions. By means of the partitions and when the membrane is almost inflated, there is obtained a straight line along the seams and the line has about the same angle towards the outlet as the slide angle of the bulk goods. By the partitions 6 it is prevented that the membrane 1 is excessively inflated so that the outflow of the goods is prevented.

Moreover, it is prevented that the area close to the outlet is raised so much that a barrier is created, which prevents the outflow of bulk goods.

In Fig. 4 there is shown that the connection between the partitions 6 and the membrane can be provided with a reinforcement in the nature of a rigid strip

15. This strip facilitates the formation of the correct slide plane and slide angle. This strip can be a plastic strip, which is attached above the membrane 1, as is shown more closely in Fig. 6, and is provided with an outer lining 9 of any slippery or smooth material. Several known materials can be used, such as TEFLON<sup>®</sup>, so called non-friction materials, glaze, enamel, polished steel etc. The strip 15 can also be an air cushion which is inflated to a higher pressure than inside the space 8. Other solutions are suggested e. g. in the above-mentioned U.S. patent specification US-A-3.202.461.

In Fig. 4 there is shown in phantom lines that the strips 15 may be held down by wires 5 which may be attached to the bottom of the silo. However if these wires were the only means to hold down the strips 15, the anchoring means for these wires must be heavily reinforced which is expensive if possible at all. During the experiments carried out by me, such anchoring wires completely broke the bottom of the silo in which the apparatus was installed. Thus it did not seem possible to use this technique at all in silos having a considerable height and diameter. However, by attaching the partitions by seams or welds to both the bottom part and the upper part of the membrane it was achieved that the force holding down the upper part of the membrane was distributed over a substantial surface of the bottom part of the membrane. Thus both the bottom part and the upper part of the membrane form bulges between the partitions and the forces are completely taken up by the membrane itself. In such an application it is evident that the membrane must be double-sided as shown in Figs. 1 to 4.

In certain non-demanding applications, it is possible to replace the partition in Fig. 3 (that is without the strip 15) with several wires 16 as is shown in phantom lines in Fig. 3. In this case the membrane will bulge between the attachment points but this bulging is so small that the emptying essentially is not influenced upon. A skilled person realize other possible modifications.

For such types of goods which have adhering properties, e. g. coal, ferrous sulphate, kaolin, sodium sulphate, and many dressed ore, it may be advantageous to generate a movement of the membrane in the transversal direction in order to break down the cohesive forces in the bulk goods.

This is achieved by the fact that the slide plane is flexibly attached to the outlet opening as shown by 12 in Fig. 3 and extends so far out through the opening 13 that a mechanical element, e. g. a crank rod, impact hammer, vibrator etc 14 may be attached to this extension 12.

The membrane 1 is shaped as a closed space or in the shape of a double-sided membrane in which one side of the membrane abuts the bottom of the container while the other side is inflated as clearly appears from Fig. 3. With this construction it is not necessary that the bottom of the silo is air-tight. In certain applications it may be possible to use a single-sided membrane.

By the device according to the invention it is avoided that the space below

the membrane 1 is inflated by an excessive amount of air and a very efficient emptying of the container is achieved.

In Fig. 5 there is shown an application of the invention in a rectangular container. The membrane is shown in its inflated position and is provided with constructed sliding planes or reinforcement strips 15. The bottom of the container is air-tight and forms together with the membrane 1 said space 8.

As mentioned above, the greatest advantages with the present invention is achieved with a cylindric container of a considerable height having a central outlet opening in the bottom surface, such as a silo. The advantages of the present invention can also be used in other types of containers.

In certain cases it is desired to cool the grain in a silo. In the device according to the invention, there can be arranged plastic tubes provided with perforations along the seams 2 of the membrane 1 (not shown in the drawings). The plastic tubes extend forwards to the outlet opening 13 and is connected to a source of cold air, which is blown through the plastic tubes and efficiently cools the grain.

When the bulk goods have been fed out through the outlet opening 13, the space 8 is emptied through the inlet 11 or by the fact that a suction device is connected to the inlet 11. It is essential that the membrane at the emptying takes the position as shown in Figs. 1 and 2, that is with the bottom surface carefully drawn out in the corners. For this purpose, the membrane can be provided with pockets comprising a weight, such as a chain, heavy balls etc. When the space 8 becomes free from air, these weights will draw the membrane against the side walls of the silo to the position shown in Figs. 1 and 2. Alternatively, the wires 16 may be used for exerting a tractive force to the upper surface of the membrane. Also other devices can be used for positioning the membrane for a new filling of goods, e. g. an air-tight inflatable hose attached to the lower border of the vertical portion of the membrane. If this hose is inflated before the space 8 below the membrane is completely empty, the bottom surface will easily expand due to the air-cushion effect provided by the remaining air below the membrane.

The membrane 1 can be manufactured of a suitable woven material, which is coated with an elastomer so that an air-tight membrane is provided. The membrane can be reinforced in different ways if so required. As mentioned above, the reinforcing strip 15, if it is used, can be made of a material having a low friction, such as polyethylen or ROBALON®.

Although the invention is specifically intended to be used at cylindrical containers, such as silos, the invention may as well be used for other types of containers, such as cargo spaces in a ship, plane store rooms, grain stores, railway wagoons, lorries, containers or pressure tanks of different types.

The construction described above can be modified in many respects by a skilled person. Such modifications are intended to be within the scope of the invention. The invention is only limited by the appended claims.



PATENT CLAIMS

1. A device for final emptying of a container which contains bulk goods to be fed out through one or several outlet openings (13) or to an outlet device in or adjacent the bottom surface (7) of the container, whereby an essentially air-tight membrane (1) is covering the bottom surface of the container and at least a portion of the side walls but leaving the outlet opening (13) free, *characterized in that*

the membrane is double-sided and forms a closed bladder or space (8) with one surface abutting the bottom surface of the container;

a device (6) for holding down a portion of the membrane (1) is attached close to the outlet opening (13);

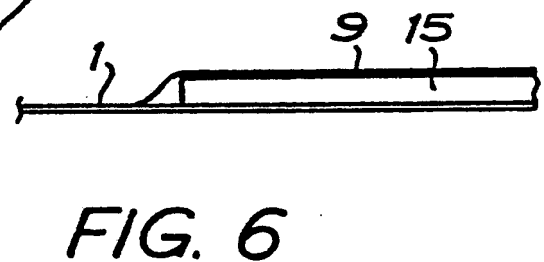
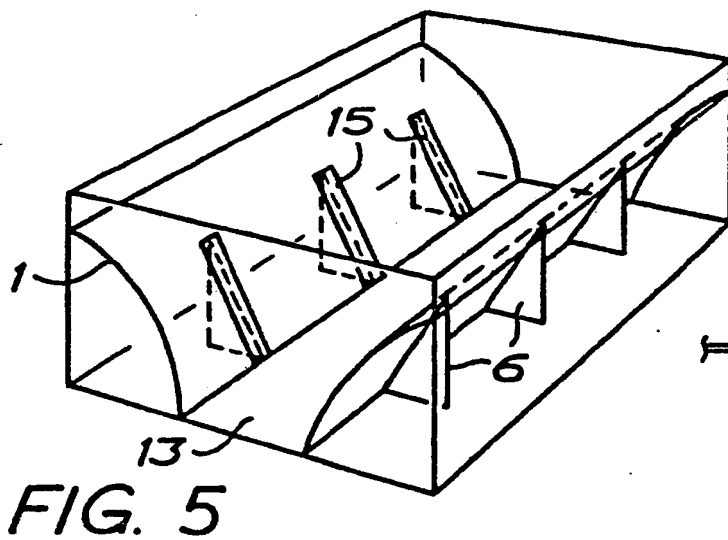
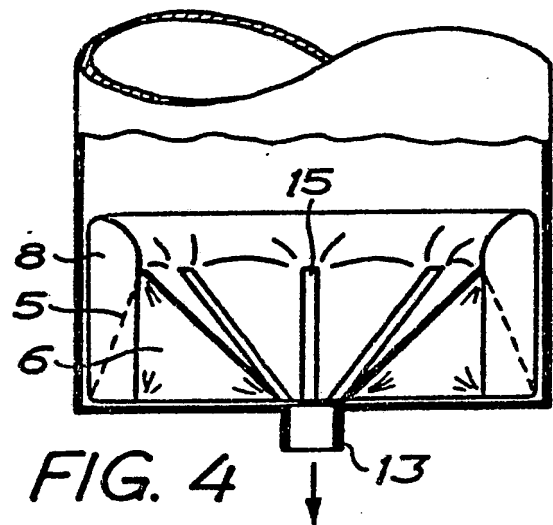
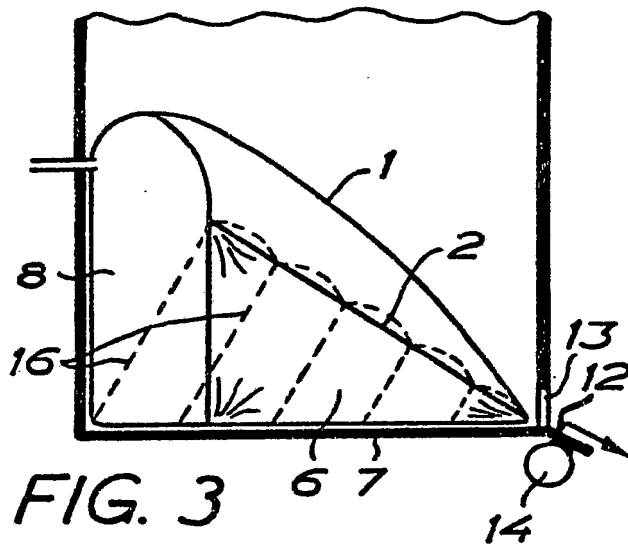
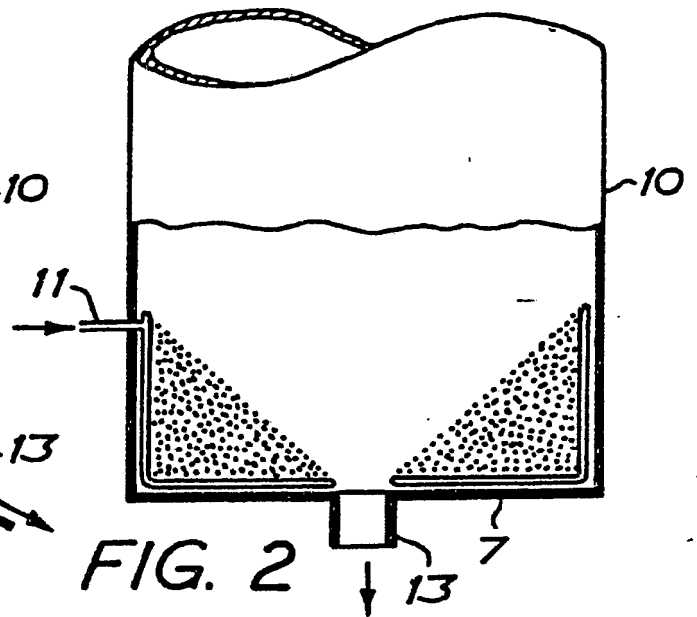
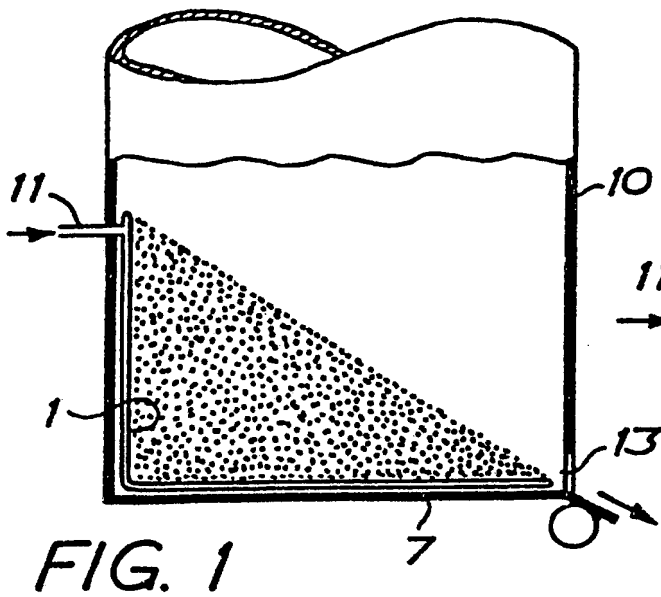
said device for holding down the membrane being triangular partitions (6) attached between the upper and the lower part of the membrane and directed from the outlet opening.

2. A device according to claim 1, *characterized in that* the partitions are attached to the membrane by seams or welds (2) and that the forces exerted when the space between the partitions and the membrane is inflated is completely taken up by the membrane itself and the membrane bulging out between the partitions both at the bottom part and at the upper part thereof.

3. A device according to claim 1 or 2, *characterized in that* the device (6) for holding down further comprises essentially rigid sliding planes (15) directed towards the outlet opening and attached to the upper part of the membrane.

4. A device according to any of the preceeding claims, *characterized in that* the membrane (1) is provided with a device for urging the membrane to be positioned flat across the bottom of the container after the final emptying of the container when the air inside the membrane is expelled.

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# INTERNATIONAL SEARCH REPORT

International Application No PCT/SE85/00172

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC:		
B 65 D 88/54		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched †		
Classification System	Classification Symbols	
IPC 2 IPC 4	B 65 G 65/54, 89/14-16 B 65 D 88/52-62, 90/02-04, 90/56; B 65 G 65/30, 65/34, 65/40, 69/06, 69/08 .../...	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
SE, NO, DK, FI classes as above		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT *</b>		
Category *	Citation of Document, †† with indication, where appropriate, of the relevant passages †‡	Relevant to Claim No. ‡‡
X	SE, C, 212 884 (AB INTERCONSULT) 16 May 1967	1, 2
X	SE, C, 168 740 (W HERMANNSS) 23 September 1959	1, 3
X	FR, A, 2 398 684 (JEAN H LAGNEAU) 23 February 1979	1, 4
X	DE, A, 2 249 783 (CARL NOLTE) 25 April 1974	1
X	GB, A, 2 105 310 (BRIAN WILLIS) 23 March 1983	1
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>* Special categories of cited documents: †‡</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1985-06-07	10 JULY 1985	
International Searching Authority	Signature of Authorized Officer	
Swedish Patent Office	<div style="text-align: center;">               Ake Carlsson           </div>	

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## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II

Fields searched (cont)

National C1 81e:136

US C1 214:17, 83.28;

222:193-195, 203, 630-637;414:287-329V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE <sup>1</sup>

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ..... because they relate to subject matter not required to be searched by this Authority, namely:2. ☐ Claim numbers ..... because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:3. ☐ Claim numbers ..... because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING <sup>2</sup>

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

## Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.☐ No protest accompanied the payment of additional search fees.